

FACDQ Rationale for Selecting Non-IUPAC Conventions for Data Measurement

Nov. 20, 2006

Committee Action

A former member of the Technical Workgroup asked for a record showing why the committee chose not to adopt, verbatim, IUPAC data measurement conventions. In response, the Technical Workgroup wishes to enter this rationale into the committee record. In addition, the Technical Work Group asks:

1. For FACDQ approval to use terminology that better reflects the conventions in the committee's current working definitions document. Adopting this terminology will avoid confusion with terms used by IUPAC to define critical, detection and quantitation levels.
2. That the FACDQ consider if it desires to change definition terms to differentiate them from IUPAC terms.

Background

This document responds to comments from a member of the Technical Work Group and an observer on the Group's calls who questioned using standards and definitions that differed from the international (IUPAC) standards and definitions for critical level (L_C), detection level (L_D) and quantitation (L_Q) level. This document clarifies the committee's rationale for moving away from the IUPAC standards and definitions and toward a different set that makes sense in light of the committee's work.

Many of the discussions that ultimately influenced the Technical Work Group's choice of standards and definitions occurred in the summer of 2005 during the Group's calls. After completing its assignments from the committee, the Technical Work Group sent issues to be resolved and recommendations on specific issues to the committee for its consideration and decision. Consequently, many decisions related to standards and definitions were made on an incremental basis. The weight of these incremental decisions ultimately tilted away from the IUPAC standards and definitions.

In developing the current set of working definitions, the committee agreed conceptually that a detection limit should be a concentration that is expected to have a high frequency of detection. The Technical Work Group recommended adopting the IUPAC Critical Value (L_C) and Detection Limit (L_D) as conceptual definitions for detection for the FACDQ. The Technical Work Group noted that detection has two components: it should address false positives (L_C) and false negatives (L_D). The Technical Work Group then converted these conceptual definitions into practical definitions that would help the committee develop detection and quantitation procedures that generate better estimates of L_C and L_D for censored and uncensored methods.

The Technical Work Group was of the opinion that the IUPAC conventions do not provide practical ways to define detection or quantitation in relevant contexts. For example, the current IUPAC definitions:

- Assume blank methods will be subtracted
- Assume constant variance
- Assume normal distribution
- Do not consider censored methods
- Are conceptual and do not include direction on how they can be implemented.

Additionally, the Technical Work Group struggled with whether to compare the signal to the blank or to zero or to adopt the IUPAC default rates of 5% for false positives and false negatives.

In the end, the committee chose to decouple its definitions from IUPAC and the subsequent calculation procedure and to develop a more general way to produce estimates with a statistical confidence that could be applied to a greater variety of measurement technologies and uses.

Current Set of Committee Working Definitions Compared to IUPAC Definitions

The following are the current working definitions the committee last discussed at its September 29-30, 2005 meeting.

1. L_C DETECTION – LAYPERSON'S DEFINITIONS

- a. Critical Value (L_C) - The minimum result which can be reliably discriminated from a blank* (for example, with a 99% confidence level).
- b. Critical Value (L_C) – The lowest result that can be distinguished from the blank* at a chosen level, α , of statistical confidence.

* Note: The committee acknowledged that the use of “blank” versus “zero” needs further discussion.

For reference, contrast the above to the following IUPAC definition:

- **IUPAC Critical Value (L_C):** The detection decision point is defined as the Critical Value (L_C). Also referred to as the Critical Level. This is set at a known type I error rate (α) (IUPAC, 1995). The default value for type I error rate (α) is 0.05 probability level. (Currie & Horwitz, 1994 and Currie, 1997)

The following are the current committee approved working definitions for detection limit, last discussed at the September 29-30, 2005 committee meeting.

2. L_D DETECTION – LAYPERSON'S DEFINITIONS

- a. Detection Limit (L_D) – The lowest true concentration that will almost always be detected.

- b. Detection Limit (L_D) – The minimum detectable value is [the] smallest amount or concentration of a particular substance in a sample that can be reliably detected by a specific measurement process.
- c. Detection Limit (L_D) – The minimum true concentration that will return a result above the critical value given a specific measurement process and confidence level.

For reference, contrast the above to the following IUPAC definition:

- **IUPAC Detection Limit (L_D):** Detection capability is defined as the Minimum Detectable (true) Value (L_d) or alternately the Detection Limit. This is set at a known type I error rate (α) and type II error rate (β). (IUPAC, 1995). The default value for both type I error rate (α) and type II error rate (β) are set at the 0.05 probability level. (Currie & Horwitz, 1994 and Currie, 1997).

The following is the current committee approved working definition for quantitation limit, last discussed at the September 29-30, 2005 committee meeting.

3. L_Q QUANTITATION

- a. **Quantitation Limit (L_Q):** The smallest detectable concentration of analyte greater than the detection limit where the required** accuracy (precision & bias) is achieved for the intended purpose.
** Note: EPA requested additional conversation around the use of the word “required” in the definition.

For reference, the corresponding IUPAC definition is:

- **IUPAC Minimum Quantifiable Value (L_Q):** Quantification capability is defined as the Minimum Quantifiable (true) Value (L_q) or alternatively the Quantification Limit. This is set at a known level of relative standard deviation, normally 10%. Empirically others have simply set it at 10 times the standard deviation of the blank assuming constant variability in this region.

A key sticking point for the committee was that IUPAC uses a relative standard deviation of 10% while many measurement technologies are not capable of 10% relative standard deviation.

Terminology

IUPAC uses the following terminology and terms:

IUPAC Critical Value - L_C

IUPAC Detection Limit - L_D

IUPAC Minimum Quantifiable Value - L_Q

The committee, up to the present, has used the following terminology and terms:

Committee Critical Value - L_C

Committee Detection Limit - L_D

Committee Quantitation or Quantification Limit - L_Q

Summary

For the reasons described above, the Technical Work Group recommends that the committee accept its recommendation not to use the terms L_C , L_D , and L_Q in future to avoid confusion with the same terms used by IUPAC. Instead, it requests that the committee use the terms Detection Limit (DL) to represent both L_C and L_D and Quantitation Limit (QL) to represent L_Q which the Technical Work Group and the Policy Work Group have done since the July 2006 meeting.

The FACDQ is requested to ratify this use of these terms in future committee and work group deliberations and documents.